

Physics 122: Electricity & Magnetism – Lecture 2 Electric Charge

Prof.Dr. Barış Akaoglu

Electricity in Nature

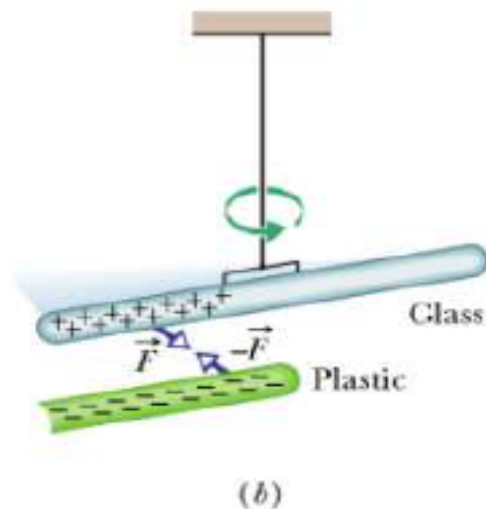
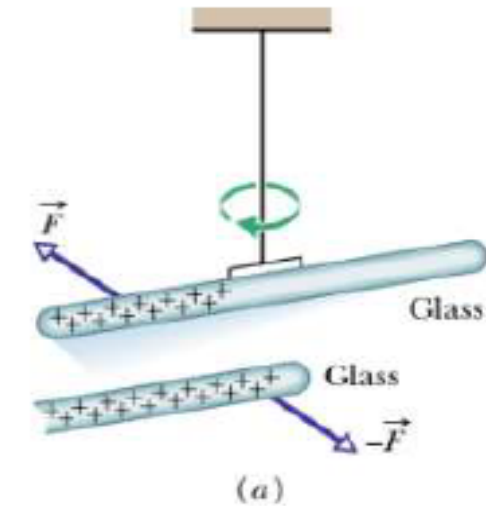
- ❑ Most dramatic natural electrical phenomenon is lightning.
- ❑ Static electricity (balloons, comb & paper, shock from a door knob)
- ❑ Uses—photocopying, ink-jet printing

Demonstrations of Electrostatics

- ❑ Balloon
- ❑ Glass rod/silk
- ❑ Plastic rod/fur
- ❑ Electroscope
- ❑ Van de Graaf Generator

Glass Rod/Plastic Rod

- A glass rod rubbed with silk gets a positive charge.
- A plastic rod rubbed with fur gets a negative charge.
- Suspend a charged glass rod from a thread, and another charged glass rod repels it.
- A charged plastic rod, however, attracts it.
- This mysterious force is called the electric force.
- Many similar experiments of all kinds led Benjamin Franklin (around 1750) to the conclusion that there are two types of charge, which he called *positive* and *negative*.
- He also discovered that charge was not created by rubbing, but rather the charge is transferred from the rubbing material to the rubbed object, or vice versa.



Forces Between Charges

- We observe that

Like charges repel each other

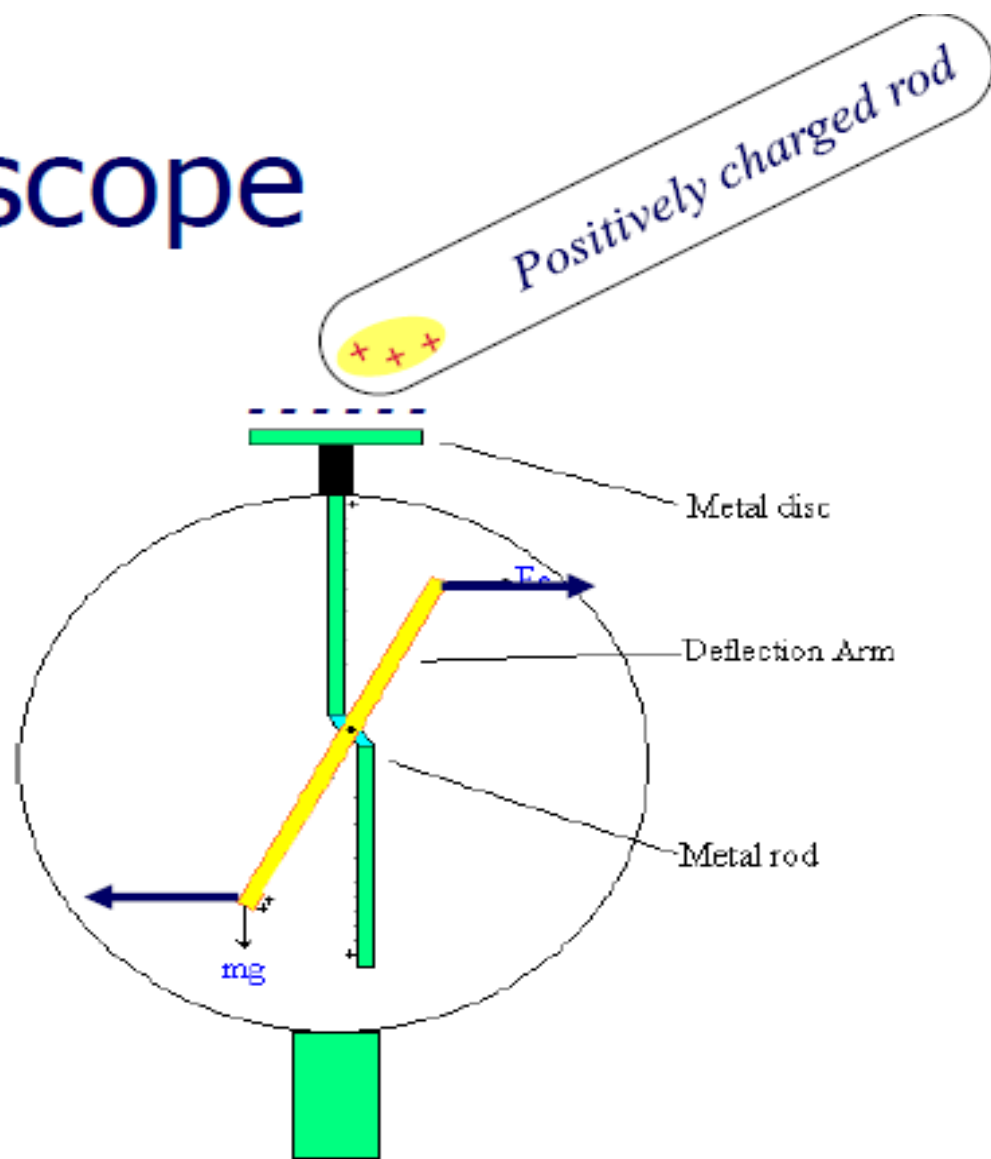


Opposite charges attract each other



Electroscope

- This is a device that can visually show whether it is charged with static electricity.
- Here is an example charged positive.
- Notice that the charges collect near the ends, and since like charges repel, they exert a force sideways.
- You can make the deflection arm move by adding either positive or negative charge.
- BUT, we seem to be able to make it move without touching it.
- What is happening?



Electrostatic Induction

The Atom

- We now know that all atoms are made of positive charges in the nucleus, surrounded by a cloud of tiny electrons.

Proton charge $+e$, electron charge $-e$
where $e = 1.602 \times 10^{-19} \text{ C}$

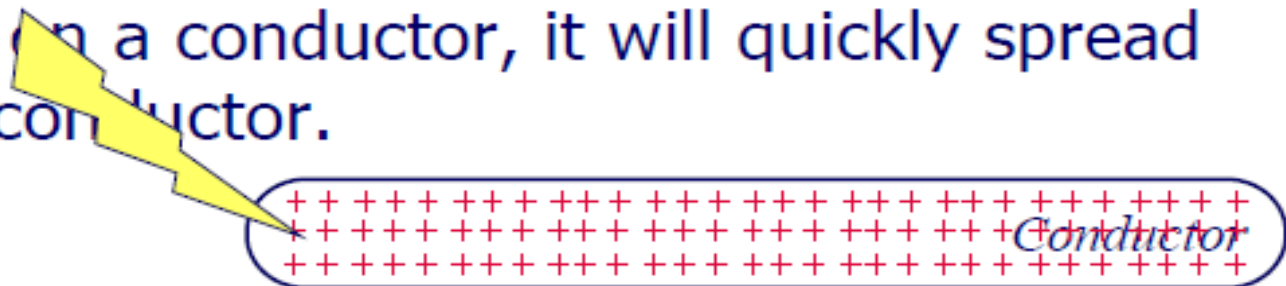
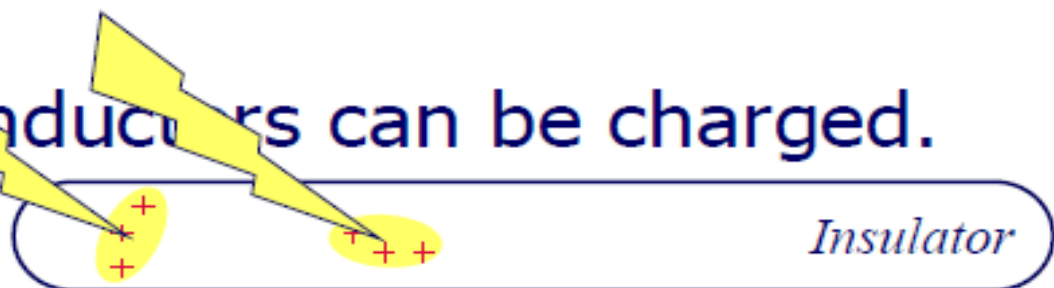
- Atoms are normally neutral, meaning that they have exactly the same number of protons as they do electrons.
 - The charges balance, and the atom has no net charge.
- In fact, protons are VASTLY more difficult to remove, and for all practical purposes it NEVER happens except in radioactive materials. In this course, we will ignore this case. Only electrons can be removed.

Insulators and Conductors

□ Both insulators and conductors can be charged.

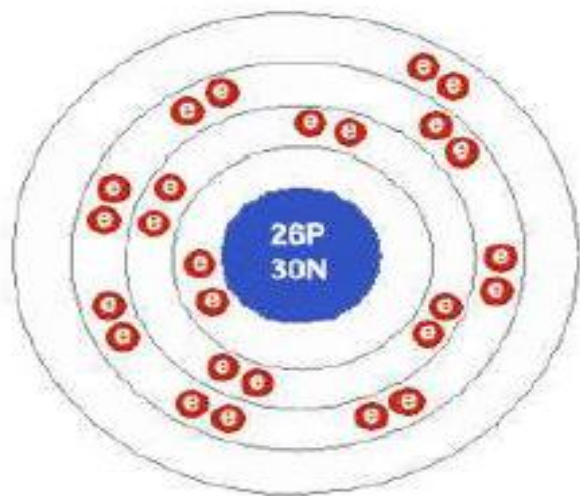
□ The difference is that

- On an insulator charges are not able to move from place to place. If you charge an insulator, you are typically depositing (or removing) charges only from the surface, and they will stay where you put them.
- On a conductor, charges can freely move. If you try to place charge on a conductor, it will quickly spread over the entire conductor.



Metals and Conduction

- Notice that metals are not only good electrical conductors, but they are also good heat conductors, tend to be shiny (if polished), and are malleable (can be bent or shaped).
- These are all properties that come from the ability of electrons to move easily.



This iron atom (26 protons, 26 electrons) has two electrons in its outer shell, which can move from one iron atom to the next in a metal.

Van de Graaf Generator

- ❑ Rubber band steals electrons from glass
- ❑ Glass becomes positively charged
- ❑ Rubber band carries electrons downward
- ❑ Positively charged glass continues to rotate
- ❑ Wire "brush" steals electrons from rubber band
- ❑ Positively charged glass steals electrons from upper brush
- ❑ Sphere (or soda can) becomes positively charged—to 20,000 volts!

